Analysis of Bed Properties on Kamb Ice Stream with Constant Midpoint Radar Profiles

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Constant midpoint radar profiles (CMP's) illuminate a fixed area on the bed or an internal reflector from a variety of angles, thereby allowing the target to be imaged through a range of ice path lengths (the so-called moveout). These experiments can be used to study ice properties (eg. velocities and attenuation) and also the reflectivity of the internal layers or areas on the bed.

Four CMP experiments were carried out on Kamb Ice Stream (KIS) in locations where the bed is suspected to be water-saturated and dry. Two of these were done as an orthogonal pair in the same (wet) location to test for anisotropy within the ice. RMS velocities to all imaged internal reflectors and the bed have been calculated for each of the profiles using a semblance analysis. RMS velocities decrease with depth to values near 173 m/μs as higher velocities within the firn make a smaller contributing fraction. From these RMS velocities we extract a velocity versus depth function at each location.

We have also modeled the variation in reflected power as a function of illumination angle (and thus path length) based on the Radar Equation and Fresnel's Equations. From these calculations we have extracted the coefficient to the exponential term in the Radar Equation accounting for the dielectric losses due to scattering and attenuation. These losses can be characterized by the mean path length in the ice, L, for radar reflectivity to decrease by 1/e. By comparing L for internal layers and the bed at different depths, we find a rough measure of the mean absorption path length as a function of ice thickness, L(z). In these studies, reflections from deeper ice show more absorption per unit length than reflections from shallower ice, presumably showing the effects of temperature on absorption with colder ice in the upper layers being less absorptive.

Knowing the absorption losses based on the path increase from the individual cmp moveouts, we use this information to compute the depth-corrected reflectivity of internal layers and of different locations on the bed. From this we characterize the dielectric reflective properties of these respective regions and internal layers. Our results show that the deep wet bed in the northern branch trunk of KIS still flowing in excess of 100 m/a is several orders of magnitude more reflective than the bed in the lower trunk.